BARBER COLMAN

INSTRUCTION MANUAL

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MA32102

BARBER-COLMAN COMPANY
Industrial Instruments Div. • Rockford, Ill., U.S.A.

1211.8
IN 5-6

MODELS 281L and 281L-1

LIMITROLS

INSTRUCTION MANUAL

This instrument is FM approved.

BARBER-COLMAN COMPANY
Industrial Instruments Division

Litho in U. S. A.

January 1968

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MATERIAL WARRANTY

All equipment except tubes, photocells, and thermocouples, which within one year from date of shipment is found to have been originally defective, will be repaired (replaced if necessary) free of charge if returned prepaid to the Factory at Rockford, Illinois.

General Description

The Series 281 Limitrol is a millivoltmeter-type indicating two-position or "on-off" controller using a solid state trigger-type circuit to operate a single pole double throw relay.

The Limitrol is used to provide insurance against human or instrument failures which may exceed critical temperatures. Their use as indicating safety instruments prevents temperatures from rising above the danger point of the equipment or process material.

The Limitrol will automatically shut off the fuel supply at any specified temperature manually pre-set on the indicating scale and, if so desired, sound an alarm. When used in combination with controllers and recorders, they give added protection to the entire control system.

The instrument is suitable for any application compatible with this relay action including the operation of external relays, contactors, solenoid valves, valve control motors, or any electrical load which does not exceed the instrument relay ratings.

Control Action

The control set point is adjustable by an FM approved screwdriver adjustment protected by an acorn nut on the front of the instrument. The indicating pointer indicates temperature at the thermocouple. Because solid state devices operate without warm-up time, control action is instantaneous.

When the Model 281L is powered the red lamp will light (indicating that the relay is de-energized). Instrument start-up is accomplished by pressing and holding the RESET button until the red light goes off. This indicates that the relay is energized. When the set point is exceeded the instrument goes to the off condition, the red light will come on and the "off" position of the control circuit will energize the appropriate alarm apparatus. The Limitrol will stay in this off condition until the control temperature (or other variable) is again within limits and the manual reset button is pressed to actuate the instrument relay.

The Model 281L-1 is a "delayed action" variation of the Model 281L. The relay opens 10 seconds after power interruption or an over-temperature condition occurs. If power is restored, or temperature condition corrected within the 10 second period, process operation will not be interrupted.

The Model 281L-1 is used primarily to avoid nuisance shutdowns on those applications where momentary power interruptions or fluctuating temperature conditions may be anticipated.

Description of Electronic Circuit

The Series 281 uses a transistorized oscillator and a silicon controlled rectifier (SCR) for control of the load temperature. At a position on the scale below control point, the transistor collector current is great enough to trigger the silicon controlled rectifier, energizing a relay so that power is applied to the load or process. As the indicator approaches control set point, a small vane or flag, suspended from the indicating pointer, passes between two flat coils mounted on the control set arm. The presence of the flag between the coils changes the tuning of the oscillator circuit. On the Model 281L the flag between the coils causes the collector current to reduce to a point where the SCR ceases to conduct, de-energizing the relay. On the Model 281L-1, the same action takes place except that a resistor-capacitor-diode network permits an 8 to 10 second delay before the relay will be de-energized.

Once the relay has been de-energized, either model will remain so until the push button on the front of the instrument is pressed.

Series 281 Specifications

Scale Length	5 inches
Minimum Span	9 mv or 0-300°F- Type J
Calibrated Accuracy	1% of full scale
Sensitivity	90 microamps for full scale deflection (nominal)
Internal Resistance	11 ohms per millivolt
External Resistance	Calibrated for 15 ohms. Supplied with compensator to make up difference between actual external resistance and calibrated value
Compensation	(a) Automatic compensation for reference (cold) junction in the range of 40°F to 130°F (b) Copper coefficient compensation in the range of 40°F to 130°F
Thermocouple Break Protection	Furnished as standard
Control Contacts	One set of SPDT contacts

Contact Ratings	120 v	240 v
Resistance Loads	10 amps	5 amps
Inductive loads	5 amps	2.5 amps

Control Adjustment	External control set point "micro-set" knob adjustable over 100% of scale.
Power Requirements	9 volt amperes
Power Supply	120 or 240 volts a-c, 50 or 60 cycle
Dimensions and Weights:	
Overall Dimensions	6 7/8" w x 6 1/4" h x 9 5/8" d
Cutout for Flush Mounting	6 1/8" w x 5 9/16" h Note: Meter housing will extend approximately 8" from back of panel when flush mounted.
Net Weight	9 pounds
Shipping Weight	12 pounds

INSTALLATION AND START-UP

Unpacking the Instrument

This precision instrument and its associated equipment have been carefully manufactured and packed at the Factory. Remove the instrument and accessories from the packing box and check items against the packing slip. If the equipment is found to be damaged in transit, report damages to the carrier immediately. Repack in original packing box until ready for installation.

CAUTION:

Handle with care. Safeguard instrument from shock before and after installation. Avoid oil accumulation and exposure to moisture. Keep instrument temperature under 130°F and over 40°F.

Mounting Instructions

Locate instrument to avoid excessive vibration, shock, and temperatures outside the range of 40°F to 130°F. Avoid furnace walls, radiation of heat, machine frames, and outside walls. Provide suitable shelter against moisture and temperature extremes if installed outdoors. Refer to appropriate drawing for mounting details.

Power Wiring

This unit is suitable for 120 v or 240 v, 50/60 cycles a-c, by choice of proper terminals on the back of the instrument housing. Solid wire (14 gauge) is suggested for supplying power. If stranded wire is used, tin the ends to provide secure connections.

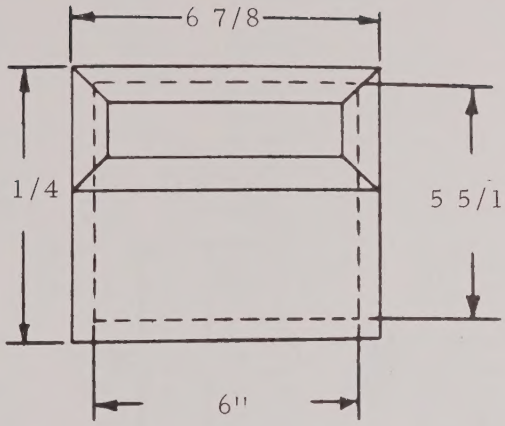
Wiring should be in accordance with applicable electrical codes. It is recommended that a fused switch be inserted in the power line to the load. The fuse size should never exceed 10 amperes at 120 volts or 5 amperes at 240 volts. If load requirements are less than these amounts, the ampere rating can be less. Where maximum protection of the instrument is desired, a 1/8 ampere slow blow fuse may also be added in the power line to the instrument.

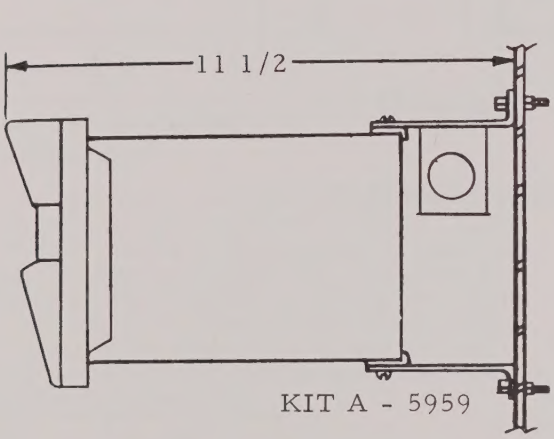
The Series 281 should be grounded. This is accomplished by attaching the GRD terminal directly to a good ground, such as a cold water pipe.

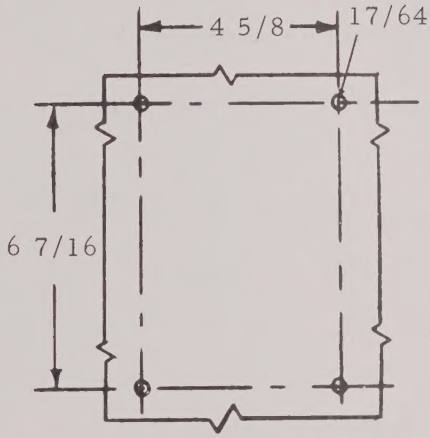
CAUTION:

Do not connect the GRD terminal to the neutral a-c line.

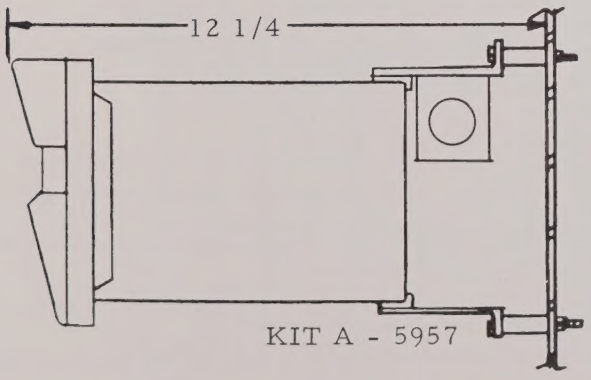
FRONT VIEW AND
CASE DIMENSIONS

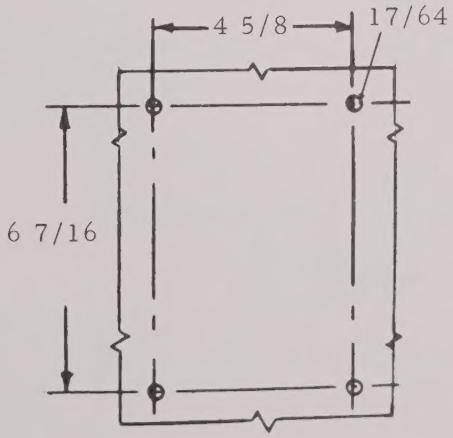






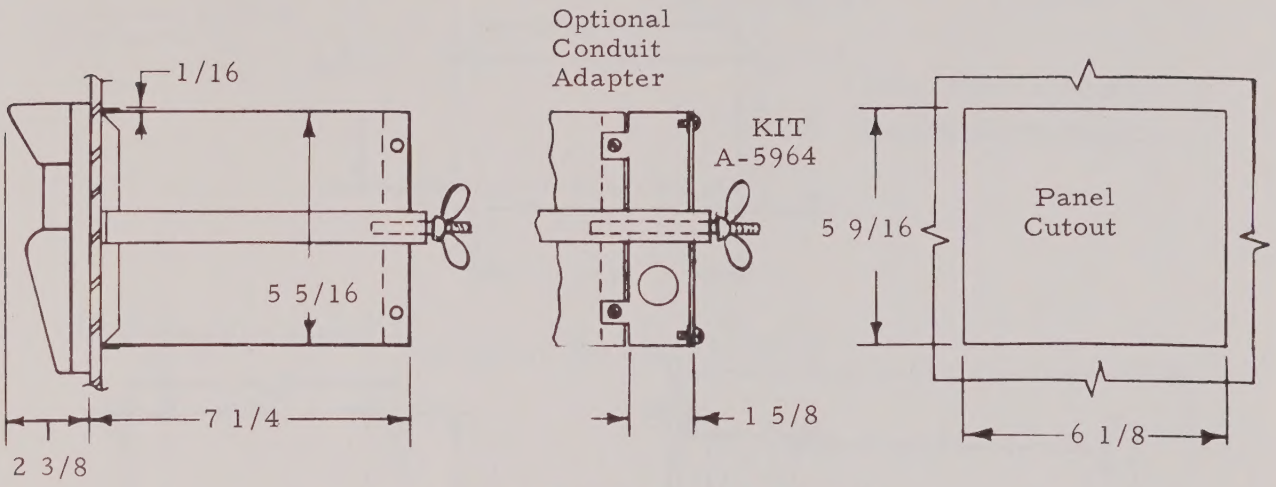
SURFACE MOUNTING DIMENSIONS



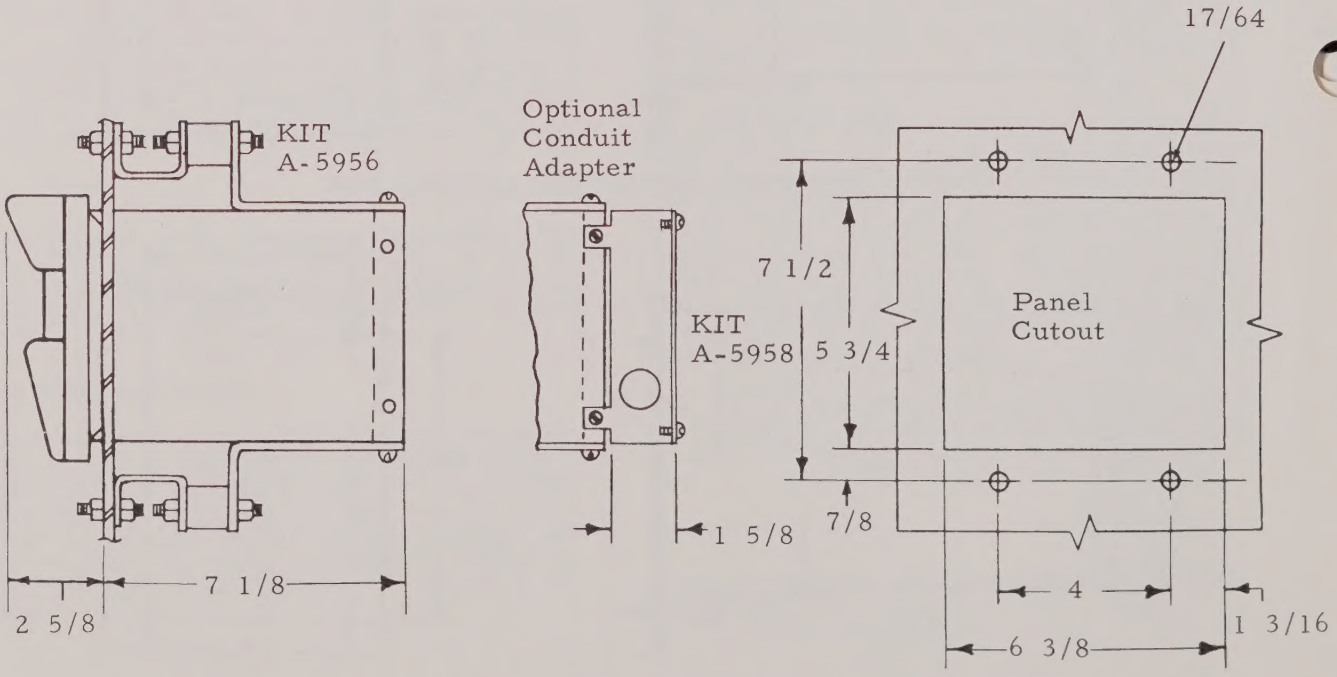


VIBRATION MOUNTING ARRANGEMENT FOR SURFACE MOUNTING

Figure 1



FLUSH MOUNTING DIMENSIONS



VIBRATION MOUNTING ARRANGEMENT FOR FLUSH MOUNTING

Figure 2

Terminals 1, 2 and 3 are wired internally to the relay contacts with terminal 2 as the common point of the SPDT contact. Terminal 1 is the normally closed contact and terminal 3 the normally open contact as shown in Figure 3. The external wiring diagrams (Figures 4 and 5) show some typical wiring diagrams.

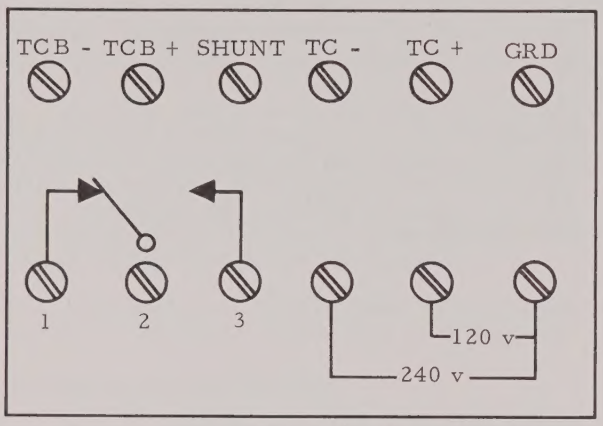


Figure 3. Terminal Layout

Meter Shunt Wire

After the instrument is installed, disconnect the jumper wire across terminals marked "Shunt" and "TC-". This wire is used to shunt or dampen the meter movement for protection during shipping, handling and installing the instrument, but should be removed for normal operation. Replace the shunt wire when handling or shipping the instrument and position the control set pointer fully upscale.

Thermocouple Wiring

The single unit meter and chassis plug-in assembly has a thermocouple selection feature which should be checked to see that thermocouple connections are properly made. This is done by removing the instrument from its case and noting the pin connections on the small terminal board at the rear of the meter enclosure. The leadwire marked "A" should always be connected to pin "A" and the leadwire marked "B" should always be connected to pin "B". If a base metal thermocouple is used (Type J, T or K) the wire labeled "C" should be connected to the third pin, marked "C or D". If a noble metal thermocouple is used (Type R or S) the wire labeled "D" should be connected to this pin.

Do not run thermocouple leadwire with other power or control wiring. Leadwire may be run with thermocouple break (TCB) wires, however. Several thermocouple leadwires may be run in the same conduit if desired.

Use only extension leadwire correct for the type of thermocouple (TC) as specified on the scale. The types most commonly specified are: Iron-Constantan (Type J), Chromel-Alumel (Type K), Platinum-Platinum 10% Rhodium (Type S), Platinum-Platinum 13% Rhodium (Type R), and Heat-Eye. Ordinary copper wire must not be used for these elements, although it can be used with Barber-Colman Land Radiation Pyrometers and certain other radiation detectors. See Barber-Colman Thermocouple Catalog for a full selection of thermocouple assemblies and extension leadwire.

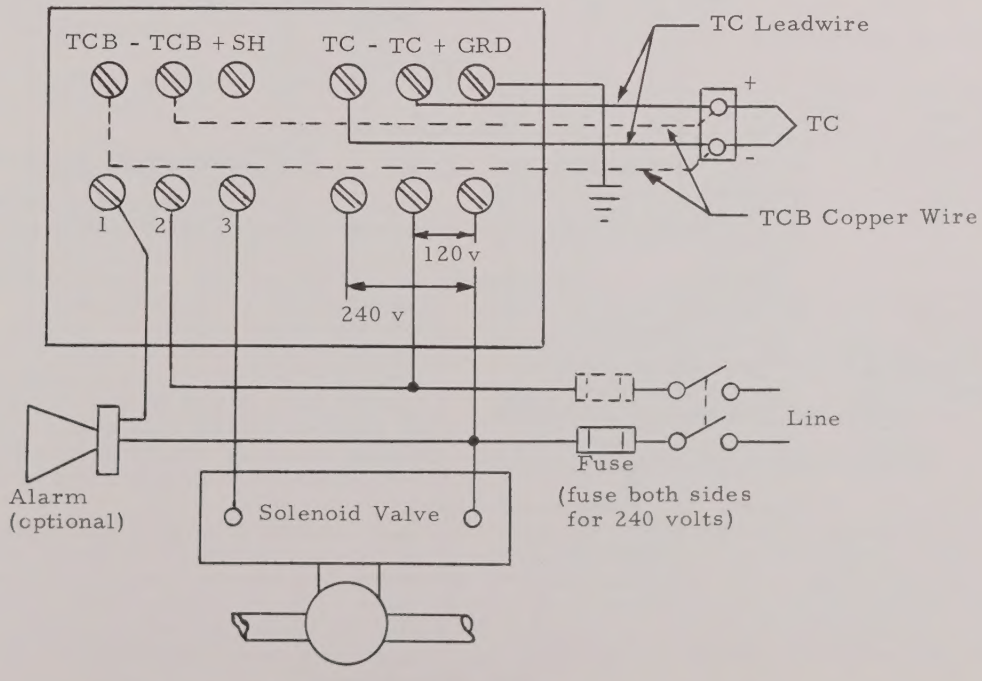


Figure 4. Model 281L with Solenoid Coil or Load Under 5 Amperes

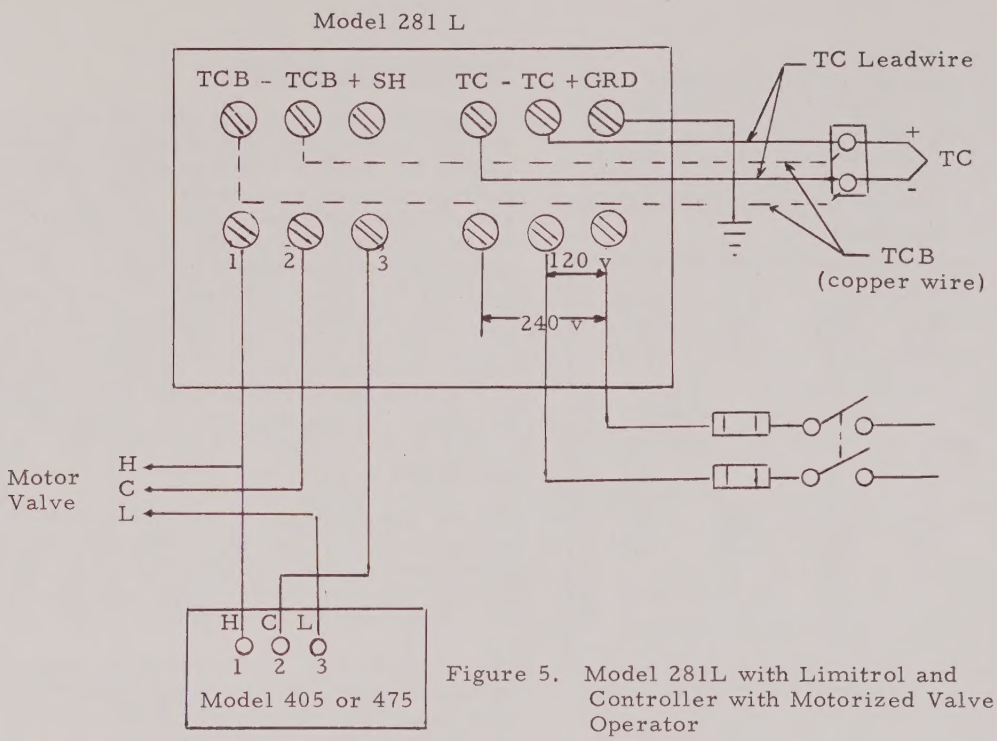


Figure 5. Model 281L with Limitrol and Controller with Motorized Valve Operator

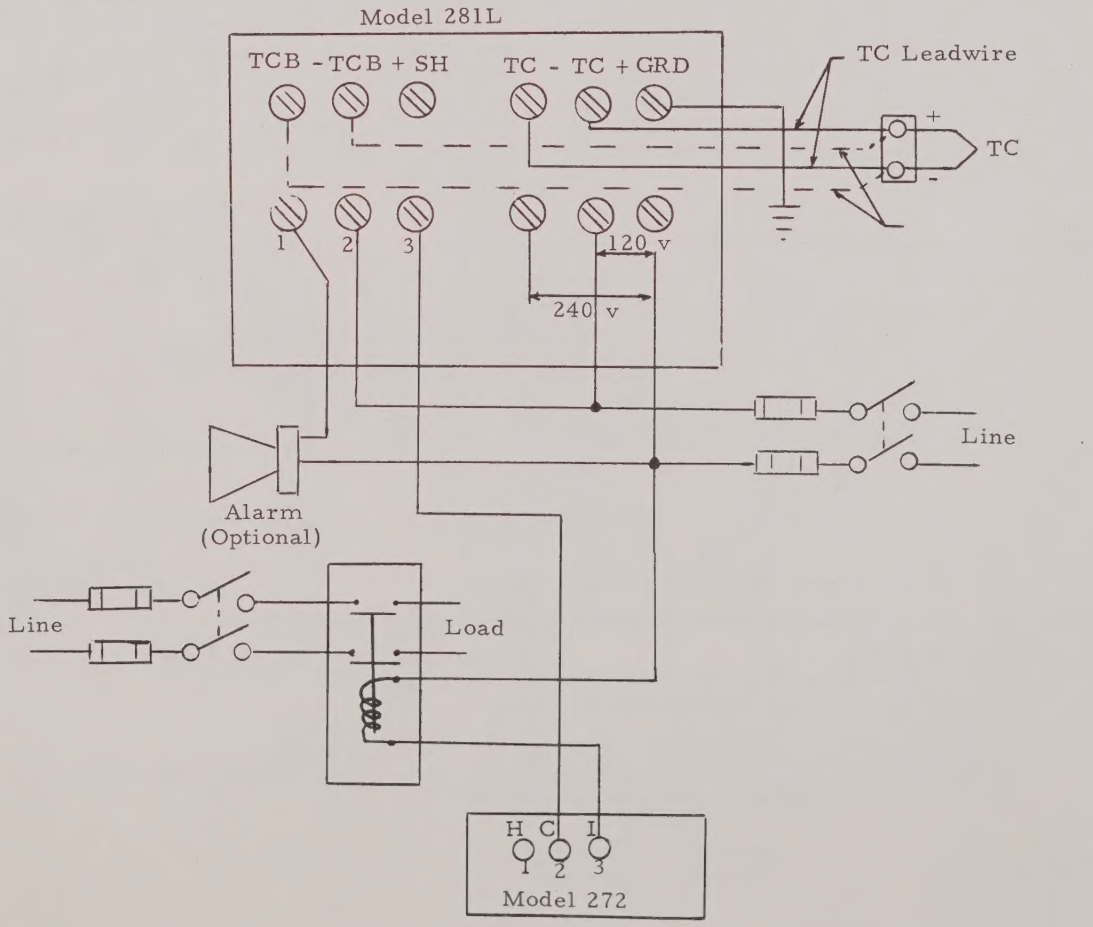


Figure 6. Model 281L with Limitrol and Controller with Load Over 5 Amperes

Proper polarity (+) and (-) of the leadwire must be observed to obtain correct readings. The negative wire is usually coded red. Correct polarity of the leadwire can be checked by twisting the two wires together at the far end, heating this junction with a match, and noting the deflection of the meter indicator. An upscale deflection is proof of correct polarity of the leadwire.

The leadwire should then be connected to the thermocouple and the indicating pointer should again deflect upscale when the thermocouple hot junction is heated. If the indicator moves downscale, reverse only the connections at the thermocouple since the leadwire has already been correctly connected to the instrument.

Secure the leadwires firmly under the terminal screws. If desired, spade lugs may be used.

Line Compensating Resistor

The external resistance, for which the meter has been calibrated and as marked on the scale, is the combined resistance of the extension leadwire and thermocouple. Meters are normally calibrated for 15 ohms (Ext. Res. 15 ohms), which allows for more resistance than the average length of leadwire. The balance of the resistance, 15 ohms minus the actual external resistance, is supplied as a removable compensating resistance spool located on the negative TC terminal at the back of the instrument. The resistance value is marked on the spool which is attached at the time of the original order. Minor changes in the leadwire length can be made without appreciable error in reading because a high resistance movement is used.

Compensating resistors of other values can be obtained at nominal cost.

Thermocouple Break Protection (TCB)

The instrument is equipped with thermocouple break protection (TCB) to be used if desired. This protection is provided by a small d-c voltage superimposed onto the thermocouple circuit so that, in the event of a break in the thermocouple circuit, the meter movement will be driven upscale past the control set point and the instrument control will go the OFF position. The instrument will operate in a normal manner without the TCB connected, but its use may be desired on some applications to guard against overheating in the event of an open thermocouple.

Methods of connecting TCB are shown in Figure 7. Use the required extension leadwire to make the connections between the instrument terminals and the thermocouple head. Copper wire, 16 or 20 gauge, is used to connect the TCB terminals to the thermocouple head, observing polarity.

Wiring for TCB may be run in the same conduit with thermocouple leadwire. Although not recommended, an optional method of connecting TCB is to use jumpers at the instrument terminals as shown by the broken lines. This method is suggested only for use with short leadwire lengths (10 feet or less). When using longer lengths of leadwire, this method may result in a noticeable error in the meter reading. The amount of TCB error must then be determined. (See section on Meter Adjustment.)

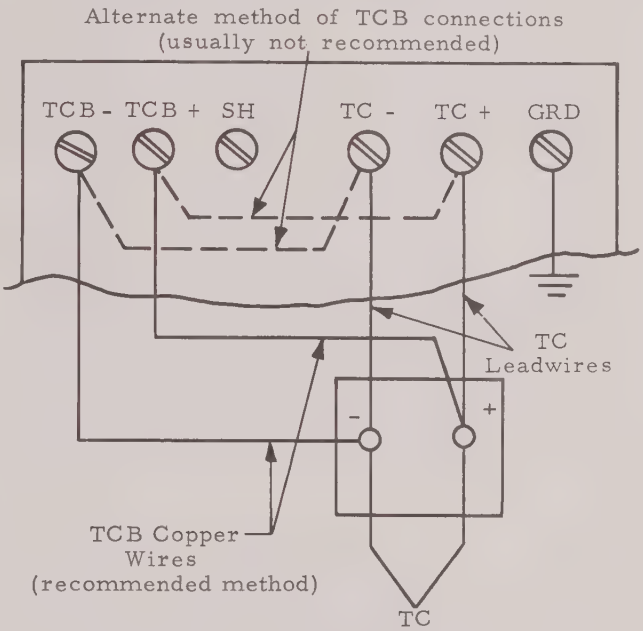


Figure 7. TCB Wiring Methods

To check for correct TCB operation, disconnect the thermocouple to simulate a broken thermocouple but leave the TCB wires connected. When the instrument is powered, TCB is functioning properly if the indicator is driven upscale above the red control set pointer to cause the control to go to the OFF position.

TCB is not effective on radiation detectors because of the compensating network in those devices. Do not connect TCB when the instrument is used in conjunction with a Series 350 Reference Voltage Source. See Series 350 Instruction Manual for complete instructions.

Removing Instrument from Housing

The meter and chassis are single-unit constructed with plug-in connections to the rear terminal board. For servicing or interchange of control forms, the complete unit is removed from the housing by loosening the two screws on the front face and pulling forward firmly. Do not attempt to pry the unit apart from the housing.

Meter Adjustments

Cold Junction Compensation:

For measuring temperature, thermocouples are the most commonly used sensing devices. They produce a voltage when there is a temperature difference between the "hot" or measuring junction and the "cold" junction located in the meter assembly. Since the difference in temperature between the hot and cold junctions determines the amount of millivoltage produced, it is necessary to keep the cold junction temperature constant, or to compensate for any changes that occur at this point. The Series 281 instruments compensate for temperature changes at the cold junction through the use of a bimetallic strip. After properly adjusting for ambient temperature, further correction for ambient temperature changes need not be made.

After the instrument has been mounted, and before it has been powered, disconnect the thermocouple at one of the terminals and read the temperature indicated on the scale. The indicator should not read zero, but should come to rest at the ambient temperature. Use a reliable mercury thermometer to determine the correct ambient temperature. (if instrument is mounted in a panel, measure the temperature inside the panel and allow enough time for the instrument to reach inside panel temperature.) if the pointer does not read ambient, slowly adjust the screw located on top the meter front cover until it does.

If a check of cold junction compensation is to be made after a period of operation, heat rise within the instrument must be allowed for. Because the rate of heat dissipation depends upon the environment, the heat rise will not be a constant, but will usually vary between 5°F to 10°F above the external temperature. Where close measurement accuracy is desired, a small thermometer should be placed inside the housing on top the chassis with the bulb near the meter thermocouple selection terminals. After allowing sufficient time for the inside temperature to stabilize, an adjustment should be made to set the meter indicator to the measured value.

TCB Compensation:

It is necessary to compensate for TCB only if the meter tends to read significantly high when the instrument is powered. Should it be desired to compensate for this upscale deviation, the reading may be shifted downscale as explained below:

With the instrument previously adjusted for correct ambient temperature, the thermocouple should be held at a steady temperature while observing the difference in meter readings with the unit powered and unpowered. If the difference is discernable, compensation may be made with the ambient temperature adjusting screw. With the instrument powered, turn the screw to lower the indicated reading to the same point on the scale as observed when the power was off. The cold junction or ambient adjustment is thereby also changed downscale. An alternate method of making this check is by making and breaking the TCB circuit.

Control Adjustments

The Series 281 is furnished with a push button, located to the right of the red light. On the Model 281L, the push button is used to pull in the relay at start-up, power interruptions, and after the control temperature has returned from above control point to within limits. The Model 281L-1 push button is used in a like manner, except it will not need to be depressed after a momentary power interruption or momentary over-temperature condition (8 to 10 seconds duration).

Reset:

A "reset" adjustment is located on the right front of the control chassis, accessible by removing the access cover located below the set point adjustment screw. The cover is removed by pulling on the small knob located below the control set point adjustment screw.

Reset adjustment provides a means of aligning the control action with the indicator. If the control action does not occur when the meter indicator coincides with the control set pointer, an alignment adjustment should be made. Use a small screwdriver to reposition the reset running screw. Turning the reset adjustment screw CCW will cause the relay to de-energize and the red light to come on sooner. Conversely, turning the reset adjustment screw CW will cause the red light to come on later. The control action will also occur later. The proper reset adjustment occurs when the relay is de-energized, or the red light is energized, at the moment the indicator pointer coincides with the control set point. Final control action adjustment should not be made until after the unit has obtained maximum stability.

Differential:

A potentiometer is factory adjusted to require approximately a .010" motion of the pointer to cause the control action to change from ON to OFF. This setting handles the majority of applications and should not be readjusted except by a qualified instrument repair man. To change the operating differential of the instrument relay, unplug the instrument from the housing to expose the potentiometer (R2) mounted horizontally on the printed circuit board. It is the disc type blue or silver colored pot, located on the right side of the circuit board. After breaking the glyptol seal, it may be turned by a small screwdriver. Turning CW will widen the differential; CCW will reduce it. Too narrow an operating differential may cause a chatter of the instrument relay.

Routine Servicing

The Series 281 instrument is well designed and manufactured of high grade components and with normal care will give uninterrupted service for a long time. It is good practice, however, to have information as to service and spare parts for emergency servicing. Where a number of instruments of this series are located together, the single unit meter and chassis plug-in assemblies are interchangeable to allow minimum inventory.

When trouble is encountered, the service man should familiarize himself with the process and instrument application to determine the exact function of the instrument as applied. The instrument trouble usually can be traced to two basic problems: measurement or control.

Measurement and Control Trouble

Measurement trouble can be detected by observing the pointer position. If the measured temperature is known to be in error, check the following:

1. Open or broken thermocouple, leadwire or connector.

2. Deteriorated thermocouple. Compare reading with a test thermocouple.

3. Check to see that the capacitor is properly connected between the thermocouple input terminal and the ground terminal inside the back panel of the meter-chassis unit. Also ascertain that the instrument is properly grounded.

4. Accidental shorts, grounds or moisture in the leadwire (especially with asbestos type insulation).

5. High resistance in leads due to loose connectors, poor splicing, dirty switch contacts, and other faulty connectors.

6. Problems caused by vibration or shock.

7. Meter accuracy. This can be checked with a Barber-Colman portable potentiometer (or equivalent).

8. Errors due to oil and grease. Do not oil or grease any part of the instrument.

9. Incorrect cold junction (ambient) setting. The correctness of this setting should be checked following any other meter servicing. See page 13.

Control trouble may be detected by observing control point and indicator pointer position. If control action does not occur at control point, do the following:

1. Check electrical connectors and correctness of line voltage. Ascertain as to whether trouble is internal or external to the instrument.

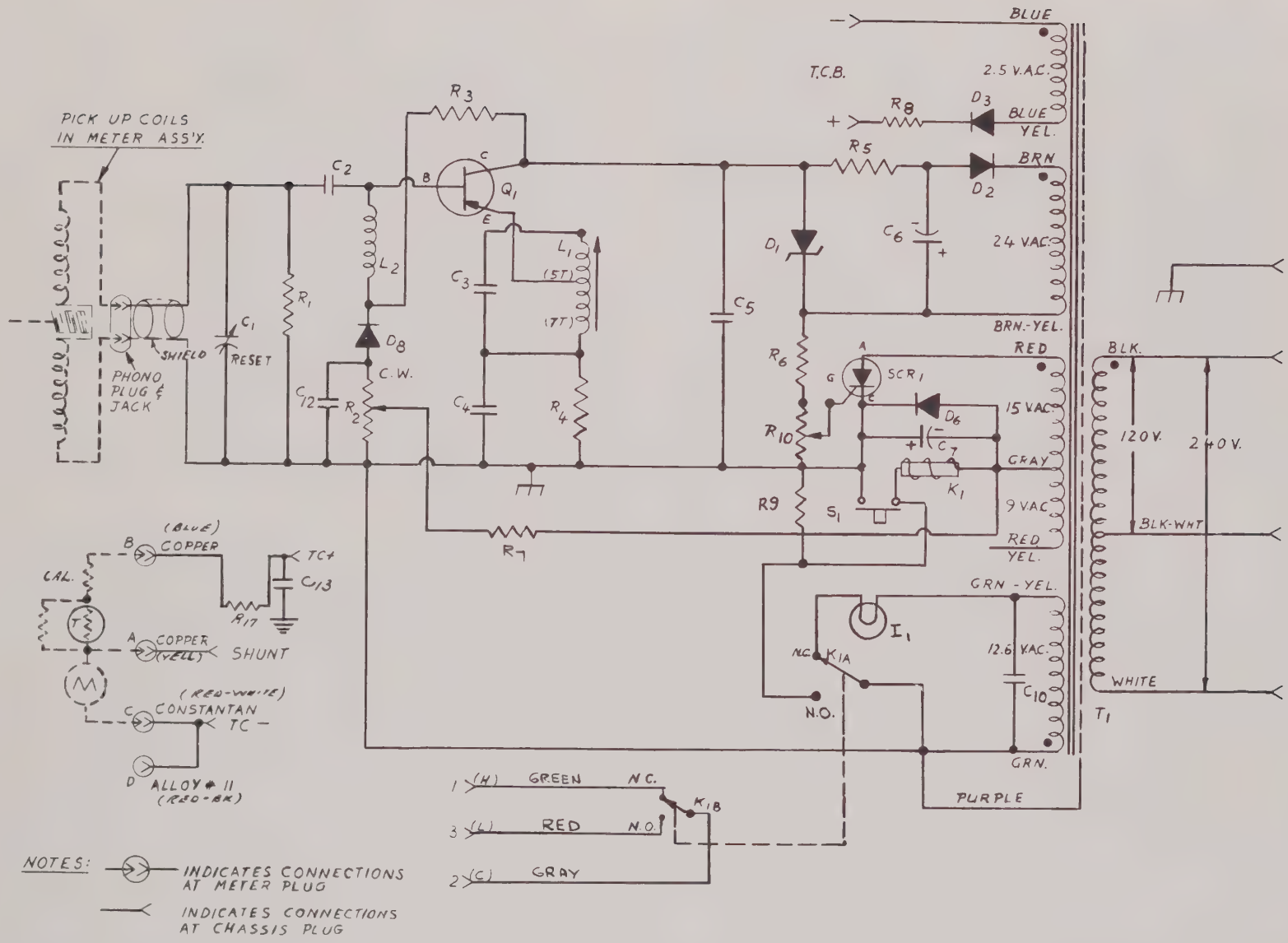
2. Adjust manual reset as described on page 14.

3. If the instrument does not operate (i.e., red light does not glow), make sure the meter indicator is downscale from the control set point and turn the reset adjustment through its entire adjusting range. If the instrument then turns on, let the controlled load stabilize, after which proper reset adjustment can be made as described under "Control Adjustments". If the instrument does not turn on, further servicing or replacement of the unit is suggested.

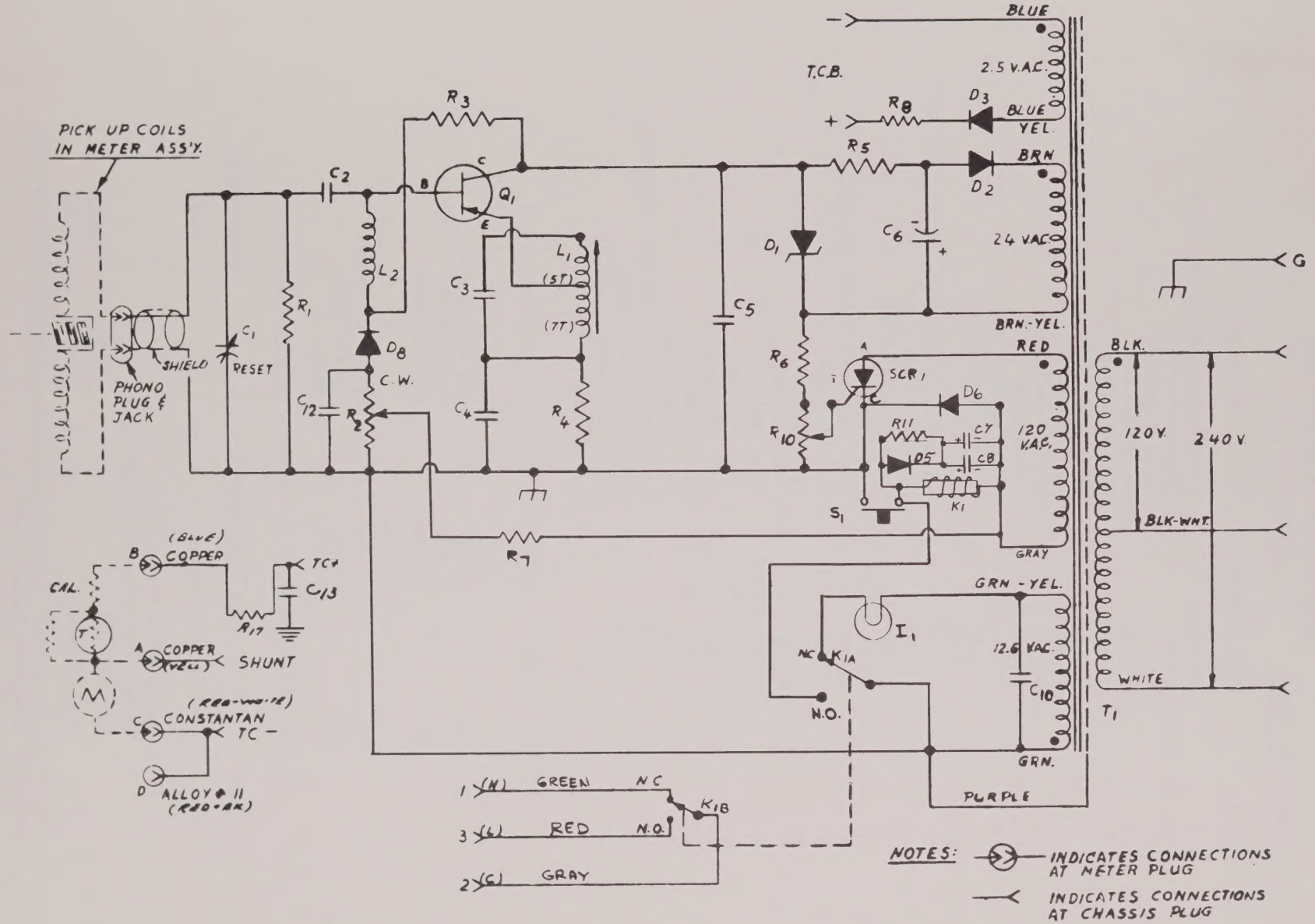
Calibration Check

The instrument has been calibrated at the Factory to the specified limits of accuracy. Under ordinary circumstances, no further adjustments need be made. If, however, it is later decided to check the calibration, connect a Barber-Colman Portable Potentiometer to the thermocouple terminals and follow the steps as outlined in the Portable Potentiometer Instruction Manual.

An alternative method of making connections to the portable potentiometer is to remove the instrument from its case and place it on a level surface. The leads from the portable poteniometer may then be attached to pins "B" and "C" (pin "B" is positive) on the thermocouple terminal selection board. After setting the external resistance for 15 ohms, the usual calibration procedure is followed.


PICK UP COILS IN METER ASS'Y.
PHONO PLUG & JACK
SHIELD
C1 RESET
R1
C2
L2
R3
Q1
C
B
E
L1
(5T)
(7T)
C3
C4
R4
D8
C.W.
C12
R2
C5
D1
R8
D3
BLUE YEL.
R5
D2
BRN
C6
T.C.B.
BLUE
2.5 V.A.C.
24 V.AC.
BRN.-YEL.
RED
R6
SCR1
R10
D6
C7
15 VAC
GRAY
K1
R9
S1
9 VAC
RED YEL.
R7
BLK.
120 V.
240 V.
BLK-WHT
WHITE
T1
GRN - YEL.
I1
NC
K1A
N.O.
12.6 V.AC.
C10
GRN.
PURPLE
(BLUE)
B
COPPER
CAL.
TC+
C13
R17
A
COPPER (YELL)
SHUNT
(RED-WHITE)
C
CONSTANTAN
TC -
D
ALLOY # 11 (RED-BK)
1 (H) GREEN N.C.
K1B
3 (L) RED N.O.
2 (C) GRAY
NOTES:
INDICATES CONNECTIONS AT METER PLUG
INDICATES CONNECTIONS AT CHASSIS PLUG

MODEL 281L


PICK UP COILS IN METER ASS'Y.
PHONO PLUG & JACK
SHIELD
C1 RESET
R1
C2
R3
Q1
L2
C3
L1 (5T)
(7T)
D8
C.W.
C12
R2
C4
R4
C5
T.C.B.
BLUE
2.5 V.A.C.
R8
D3
BLUE YEL.
R5
BRN
D2
D1
C6
24 V.A.C.
BRN.-YEL.
RED
R6
SCR1
D6
R10
R11
C7
.05
C8
K1
120 V.A.C.
S1
R7
GRAY
BLK.
120 V.
240 V.
BLK-WHT.
G
GRN - YEL.
I1
NC
K1A
N.O.
12.6 V.A.C.
C10
WHITE
T1
GRN.
PURPLE
(BLUE)
B
COPPER
TC+
C13
R17
CAL.
A
COPPER
SHUNT
(RED-WHITE)
C
CONSTANTAN
TC -
D
ALLOY # 11
(RED-BK)
1 (H) GREEN NC
3 (L) RED N.O.
2 (C) GRAY
K1B
NOTES:
INDICATES CONNECTIONS AT METER PLUG
INDICATES CONNECTIONS AT CHASSIS PLUG

MODEL 281L-1

REPLACEMENT PARTS LIST

Model 281L Parts: Electronic Parts

Item	Part Number	Description
C1	39-372-2	2.4-18.0 μμf Variable Capacitor
C2, C4, C12	39-76	250 μμf Capacitor
C3	39-87	62 μμf Capacitor
C5	39-103	.01 μf Capacitor
C6, C7	39-153	50 μf Capacitor
C10	39-196	.22 μf Capacitor
C13	39-98	1 μf Capacitor
D1	37-93	12 volt Zener Diode
D2, D3, D6	EYZP-384	Silicon Diode
D8	37-148	Silicon Diode
I1	36-34	12.6 volt Pilot Bulb
K1	A-7325	Relay
L1	41-130	2.7 μh max. 1.2 μh min. Factory Set Coil
L2	41-133	22 μh RF Choke
Q1	EYZP-623	Transistor (2N4126)
R1	CYZR-170-4	6.8K ∩ Resistor
R2	29-270	400 ∩ ± 30% 1/4 watt Potentiometer
R3	CYZR-170-1	22K ∩ Resistor
R4	40-77	270 ∩ Resistor
R5	CYZR-133-2	1.5K ∩ Resistor
R6	CYZR-170-35	820 ∩ Resistor
R7	CYZR-170-10	120K ∩ Resistor
R8	CYZR-170-38	5.6K ∩ Resistor
R9	CYZR-170-58	10K ∩ Resistor
R10	29-256	250 ∩ Potentiometer
R17	A-3152	Line Compensating Resistor Assembly
S1	32-164	SPST N.O. Push Button
SCR1	37-94	Silicon Controlled Rectifier
T1	30-164	Power Transformer

Model 281L-1 Parts: NOTE: All parts same as above except:

	Add	
C8	39-381	200 μf Capacitor
D5	37-66	Silicon Diode
R11	40-1632	10K ∩ Resistor
	Change	
C7	39-381	200 μf Capacitor
D6	37-66	Silicon Diode
K1	A-9323	Relay

SUGGESTED REPLACEMENT PARTS TO KEEP ON HAND

Quantity	Part Description	Part Number	
2	MAZDA Pilot Lamps	36-34	
1	Replacement Thermocouple (Refer to Thermocouple Catalog 1111 DB 1-3)		
		281L	281L-1
1	Control Chassis	A-7548	A-9326

We do not recommend electronic component replacement except by well equipped instrument repair shops.

Barber-Colman, Industrial Instruments Division, maintains service and repair facilities in many major cities in the United States and Canada. Consult your yellow page directory.

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